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Q-switched operation of a Nd:YAG laser at 946nm and efficient second harmonic generation in non-critically phase-matched lithium triborate

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Efficient, high-power solid-state sources of coherent visible light have many applications. One promising approach for the generation of light in the blue spectral region is via second harmonic generation of Nd:YAG lasers operating on the quasi-three-level transition at 946nm [1],[2].

In this paper we describe a Q-switched diode-pumped Nd:YAG laser at 946nm with multiwatt average output power, and efficient extra-cavity frequency doubling in non-critically phase-matched lithium triborate (LBO) to produce blue light at 473nm. To efficiently power-scale Nd:YAG at 946nm to multiwatt power levels is significantly more challenging than on the much higher gain 1.064μm line. The main problems arise from the need to focus the diode pump beam to a relatively small beam size due to the very low gain cross-section and quasi-three-level nature of the 946nm line. This places extra demands on the beam quality of the pump source and on the resonator design, which must cope with strong thermal effects resulting from the intense pump beam. The resonator design was carefully chosen to minimise the effects of strong thermal lensing, and particularly the highly aberrated nature of the lens, by requiring that it was stable over a wide range of thermal lens powers. The resonator also incorporated a quarter-wave plate to reduce the depolarisation loss due to stress-induced birefringence [3] to <0.12%, allowing efficient linearly polarised operation with a cw output power of 4W. Q-switched operation at a repetition rate of 4kHz resulted in >0.4mJ pulses of peak power 3.9kW, corresponding to an average power of 2.2W. For frequency doubling of the Q-switched 946nm output to the blue we have used a 15mm long LBO crystal cut for type I non-critical phase-matching. Operating the LBO at an elevated temperature of~307°(as required for phase-matching), we have generated 473nm pulses of energy 90μJ and peak power 1kW, corresponding to an average power of 365mW for 2.2W of average fundamental power. The prospects for further improvements in performance will be discussed.

References

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